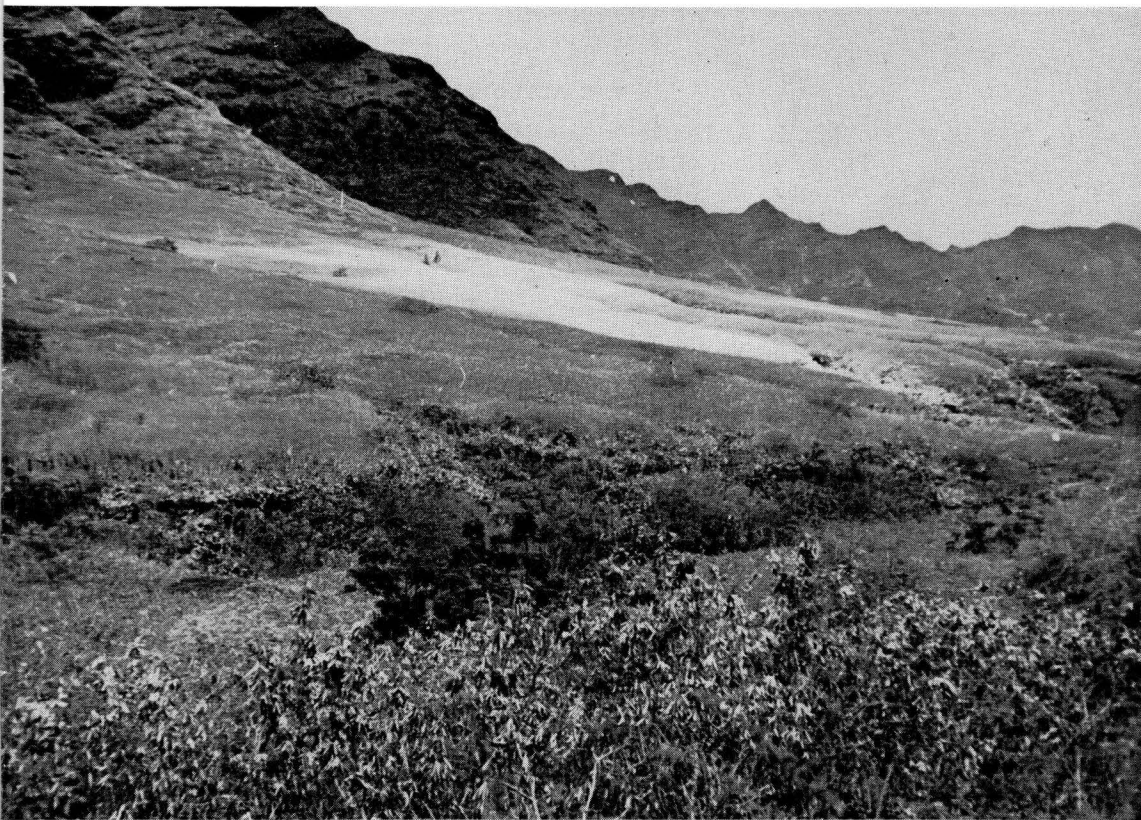


Value of *KOA HAOLE*
as a Feed for Dairy Cows

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VALUE OF KOA HAOLE AS A FEED FOR DAIRY COWS

L. A. Henke
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INTRODUCTION

Leucaena glauca, more commonly known in Hawaii as Koa haole, Haole koa, or Ekoa, is widely distributed throughout the more tropical parts of the world. Records of its introduction to Hawaii have not been found but it was known in the Territory prior to 1888 (6).

When fed to nonruminants, a marked loss of hair may result. In horses this is most evident in the mane and the brush of the tail. This depilatory action has also been noted with swine and rabbits. In rare cases, some loss of hair in the brush of the tails of cattle has also been observed. Yoshida (8) identified the depilatory principle as mimosine, which is present in the leaves as well as seeds.

Koa haole may impart a flavor to milk, especially if fed too near milking time. However, some other forages have this same tendency.

REVIEW OF EARLIER EXPERIMENTS

Numerous short experiments utilizing Koa haole as a roughage for milking cows have been conducted at the Hawaii Agricultural Experiment Station since 1929 (1). In that year, one cow grazed on Koa haole with supplementary concentrates for 60 days and averaged 38.1 pounds of milk daily—a 14 percent gain over a 30-day prior and following period when nonleguminous roughages were fed. Milk production of another cow during a 90-day grazing period on Koa haole with no concentrates averaged 29.7 pounds of milk daily, only 4.8 percent lower than that of 30 days before and after such grazing. A third cow grazed on Koa haole for 120 days without concentrate supplements and averaged 21.3 pounds, which was 3.2 percent lower than during prior and following 30-day periods on nonlegumes with added concentrates.

Double reversal 12-week trials were conducted about 1942 in which Napier grass supplemented with a concentrate ration containing 35 percent high protein concentrates was compared with Koa haole with only cane molasses and pineapple bran as supplements (5). On the Koa haole ration, 96 percent of the protein and 55 percent of the total nutrients were derived from Koa haole. Four percent fat-corrected milk production was 3.8 percent higher on the high protein content concentrate ration but this milk was produced at 27 percent greater feed cost at the then prevailing prices (2).

During periods of roughage shortage, parts of the University dairy herd were grazed on Koa haole areas on rough, undeveloped portions of University Farm (3). During such periods, a low protein concentrate ration was used to take advantage of the protein content of the Koa haole. Eight such Koa haole grazing trials averaged 22 days in length and included an average of 16 cows. Production during these periods averaged 21.5 pounds of milk

per day as compared with 21.8 pounds for the same cows during preceding and following periods when Napier grass and a much higher protein supplement concentrate ration were fed. Savings in supplementary soybean oil meal averaged 3 pounds per cow per day during periods when cows were grazed on Koa haole, although the total reduction in feed costs was not as great as might appear, since other low cost carbohydrate feeds were substituted in part for the soybean oil meal.

These earlier trials, while generally favorable to Koa haole feeding, were of relatively short duration. To test the effect of continuous Koa haole feeding, four cows for three continuous years were fed Koa haole as a soiling crop, supplemented with a low protein content concentrate ration to take advantage of the protein content of Koa haole (4). Milk production was somewhat higher and feed cost of milk production was lower when Koa haole was fed. During the three years when Koa haole was the only roughage these three cows received, no adverse effect on the condition or health of the cows was noted.

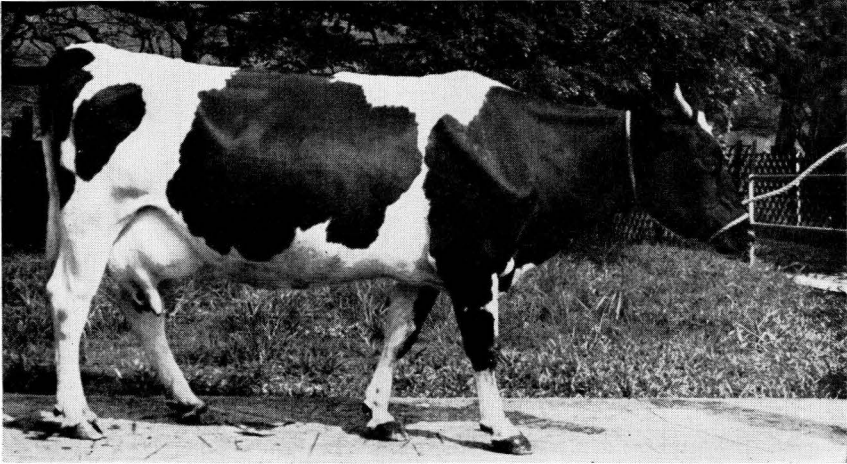
PLAN OF PRESENT EXPERIMENT

While the results of previous short tests as well as the 3-year test were favorable to Koa haole feeding, it was recognized that in the long time-trial a greater number than four cows would increase the validity of the results. Accordingly, another 5-year trial was begun October 1, 1948. Six purebred Holstein cows were selected from the general herd and divided into three approximately equal pairs on the basis of their previous milk and fat production, persistency, breeding records, and general health. One of each of the three pairs was placed in a paddock containing no vegetation and was fed only chopped Koa haole as roughage, supplemented with a low protein content concentrate (Ration N) which provided adequate protein when fed with Koa haole. The other member of the pair, known as the "companion" cow, remained with the general herd and was fed nonleguminous roughages (largely Napier grass) balanced with concentrate rations which necessarily contained larger amounts of protein.

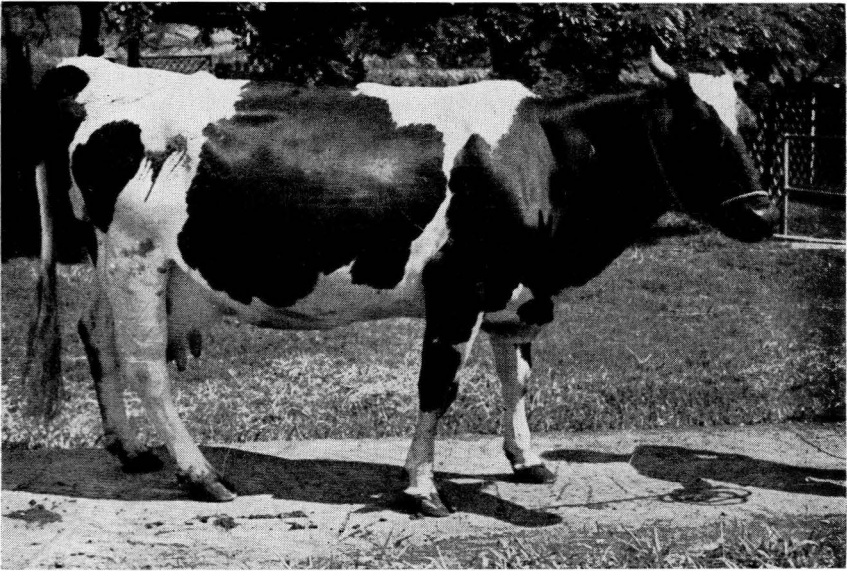
In the initial long trial it was possible to continue the original four pairs of cows throughout the entire 3-year period, but for various reasons which apparently were not occasioned by Koa haole feeding, it was possible in the present trial to continue only one of the original pairs for the entire five years. As cows had to be removed, new pairs were formed and substituted. Thus one pair was in the experiment for only three consecutive years, and the third pair for only one year, making a total of nine cow years on Koa haole feeding.

CONCENTRATE RATION FED WITH KOA HAOLE

Concentrate Ration N, consisting of 25 percent cane molasses, 40 percent pineapple bran, 10 percent soybean oil meal, 3 percent dried copra, and 1 percent each of salt and steamed bone meal, was fed as the supplementary concentrate ration to the cows receiving only green Koa haole as roughage. Ration N was estimated to contain 5.96 percent digestible crude protein and 64.91 percent total digestible nutrients.



Cow 237 on 9-29-48 before Koa haole feeding.



Cow 237 after one year on Koa haole.

KOA HAOLE CONSUMPTION AND COMPOSITION

Cows consumed an average of 60.5 pounds of green Koa haole per day over the 5-year period. A sample of Koa haole was taken each week after it had been chopped in an ensilage cutter. Composites of these samples were analyzed each quarter year. Hence 20 composites were analyzed, each based on 13 samples. The average of these analyses, as well as the range in composition, is shown in table 1.

TABLE 1. Analyses of Koa haole—20 Composites—260 Samples.

	PERCENT OF GREEN BASIS AS FED						
	<i>Moisture</i>	<i>Protein</i>	<i>Ether extract</i>	<i>Crude fiber</i>	<i>Ash</i>	<i>N-free matter</i>	<i>Total nutrients</i>
Average	70.48	5.27	0.64	9.67	1.76	12.20	28.58
High	72.46	6.13	0.86	11.38	2.23	15.15	20.01
Low	64.40	4.08	0.42	8.69	1.16	10.42	27.66
Digestion co- efficients (7).....	.....	.74	.33	.36	.....	.79	.....
Average digest- ible nutrients...	.....	3.90	0.21	3.48	.....	9.64	17.49

MILK AND FAT PRODUCTION, ROUGHAGE AND CONCENTRATE
CONSUMPTION, FEED COSTS, AND REPRODUCTIVE EFFICIENCY

Milk and fat production was computed for the fiscal years on the basis of actual production and converted mature equivalent production for both the Koa haole fed cows and "companion" cows covering the period prior to and during the Koa haole feeding period. Production data was also computed on the 305-day lactation mature equivalent basis.

Feed consumption is based on the fiscal year basis which includes feeds consumed during the dry periods between lactations. Since feed costs varied during the 5-year period, average feed prices for 1948 and 1953 were computed and applied to the quantities consumed. The roughages, green Koa haole and nonlegumes (largely Napier grass), do not have an established commercial price; they were arbitrarily valued at \$10.00 and \$6.00 per ton, respectively, for both 1948 and 1953.

Reproductive efficiency was based on months of effective pregnancy rather than on calves born, since with only a few cows the latter basis might give distorted values. During a given year, nine months of pregnancy would be considered 100 percent reproductive efficiency.

The mass of detail secured during this 5-year trial is shown in summary form in table 2.

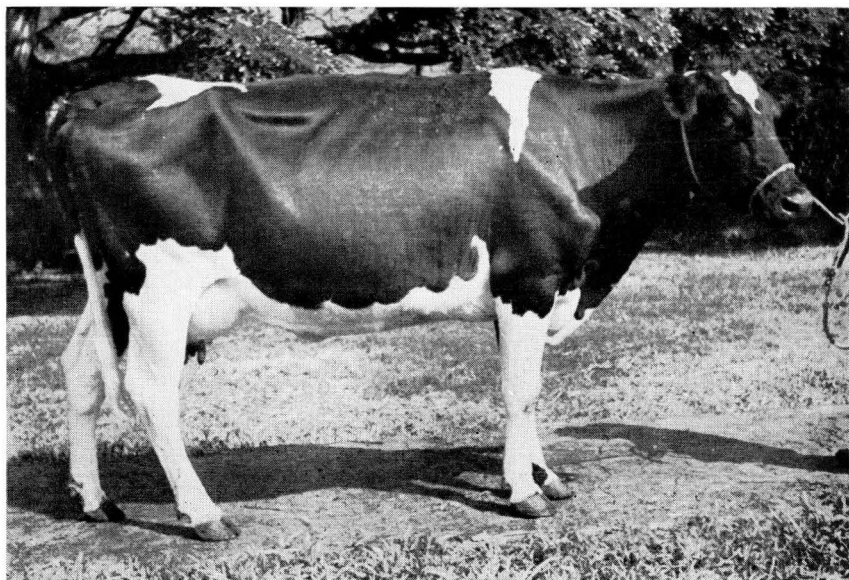
DISCUSSION

Consumption of Koa haole. Cows consumed an average of 60.5 pounds of green Koa haole per day. On the basis of applying previously determined digestion coefficients to the analyses, this quantity supplied 2.36 pounds of digestible crude protein and 10.58 pounds of total digestible nutrients per day—enough to meet the protein requirements for average milk production but not enough to meet the total nutrient requirements.

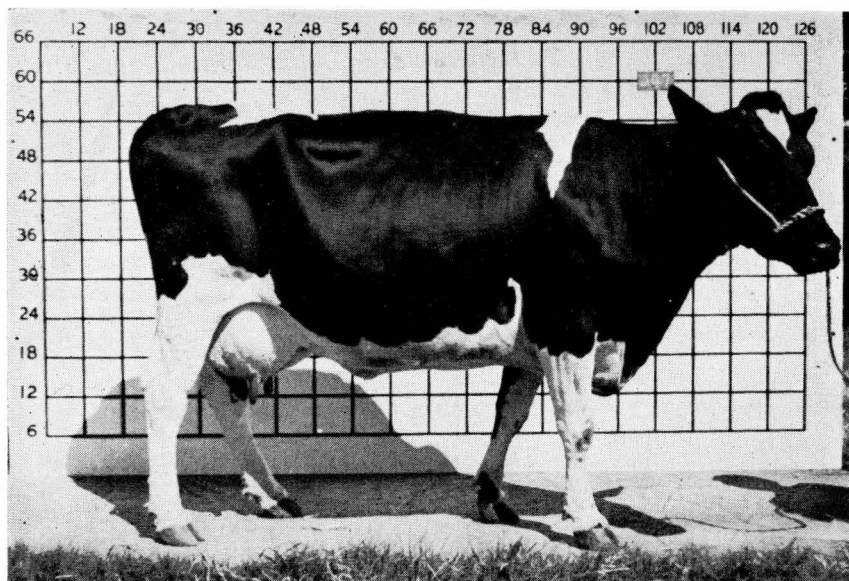
Milk Production. Milk production of the cows when fed Koa haole averaged 28.6 percent higher on an actual fiscal year basis, 14.3 percent higher on a mature equivalent fiscal year basis, and 15.3 percent higher on a 305-day mature equivalent lactation basis than when the same cows in previous years were fed nonlegumes with higher protein content concentrate rations. However, the "companion" cows, not fed Koa haole, during the same years, compared to previous records, also averaged 14.2, 8.3, and 11.9 percent higher production, respectively, during the five years when the experimental cows were being fed Koa haole. This must be attributed to better management or other favorable conditions. Deducting the gains made

TABLE 2. Summary of Milk and Fat Production, Feed Consumption and Cost, and Reproductive Efficiency.

	KOA HAOLE FED COWS			"COMPANION" COWS			COMPARISON OF KOA HAOLE AND "COMPANION" COWS DURING 5-YEAR PERIOD Koa haole cows ÷ "Companion" cows
	Preceding 7 cow years (A)	Experimental 9 cow years (B)	The percentage B is of A	Preceding 7 cow years (C)	Experimental 9 cow years (D)	The percentage D is of C	
<i>Fiscal year basis, actual average</i>							<i>%</i>
Milk, lb.....	8665	11140	128.6	8563	9778	114.2	113.9
Fat, %.....	3.29	3.60	109.4	3.70	3.67	99.2	98.1
Fat, lb.....	284.8	400.6	140.7	317.0	359.0	113.2	111.6
<i>Age converted mature equivalents</i>							
Milk, lb.....	9843	11255	114.3	9254	10021	108.3	112.3
Fat, lb.....	323.4	404.9	125.2	342.6	367.8	107.4	110.1
<i>Feed consumed</i>							
Concentrates, lb.....	5531	6402	115.7	5824	6215	106.7	103.0
Green roughages, lb.....	22844	23280	101.9	23464	21566	91.9	107.9
Molasses over roughage, lb.....	1001	1096	109.5	1043	1030	98.7	106.4
<i>Feed cost:</i>							
1948 price basis.....	\$277.35	\$295.45	106.5	\$285.57	\$282.34	98.9	104.6
1953 price basis.....	\$250.03	\$271.59	108.6	\$258.24	\$257.74	99.8	105.4
<i>Feed cost per 100 pounds of milk</i>							
1948 price basis.....	\$3.20	\$2.65	82.8	\$3.33	\$2.89	86.8	91.7
1953 price basis.....	\$2.89	\$2.44	84.4	\$3.02	\$2.64	87.4	92.4
<i>Feed cost per pound of butterfat</i>							
1948 price basis.....	\$.97	\$.74	76.3	\$.90	\$.79	87.8	93.7
1953 price basis.....	\$.88	\$.68	77.3	\$.81	\$.72	88.9	94.4
<i>305-day lactation basis— converted mature equivalents:</i>							
No. of lactations.....	8	7		8	7		
Milk, lb.....	9799	11303	115.3	9328	10434	111.9	108.3
Fat, %.....	3.25	3.53	108.6	3.68	3.66	99.5	96.4
Fat, lb.....	319.0	399.3	125.2	343.3	381.6	111.2	104.6
<i>Reproductive efficiency</i>							
Percentage of.....	98.16	87.67	89.3	102.76	89.74	87.3	97.7



Cow 247 on 10-19-49 before Koa haole feeding.



Cow 247 after 3 years on Koa haole.

by the "companion" cows leaves a net increase of 14.4 percent on the actual fiscal year production, 6.0 percent on the mature equivalent fiscal year basis, and 3.4 percent on the 305-day lactation mature equivalent basis; these gains may be fairly credited to Koa haole feeding. Since fat tests averaged higher when Koa haole was fed, the increases on the basis of fat production are even higher, as will be noted in table 2.

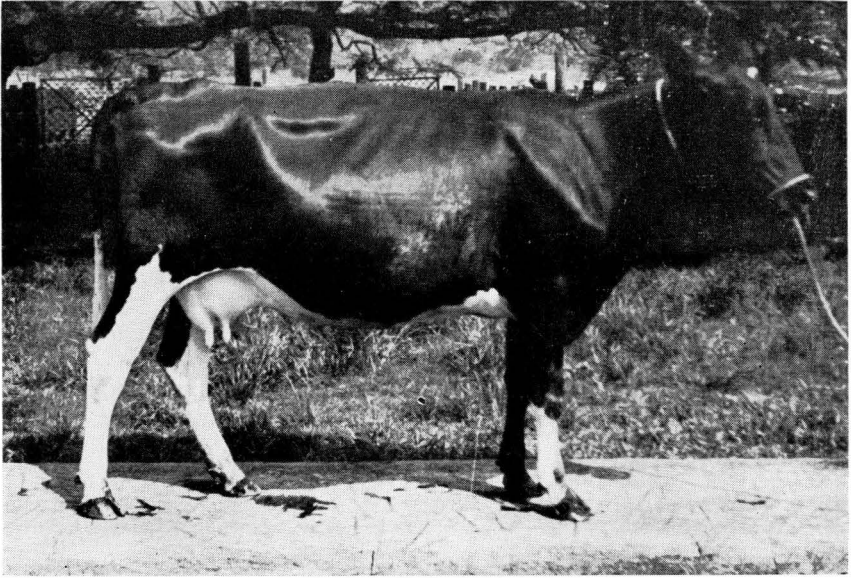
Cost of Milk and Fat Production. Evaluating green Napier grass at \$6.00 and green Koa haole at \$10.00 per ton, and other feeds at actual cost on 1948 and 1953 prices of feeds basis, the cost per unit quantity of milk produced during the experimental 5-year Koa haole feeding period was 82.8 percent that of the preliminary period on the basis of 1948 prices and 84.4 percent on the basis of 1953 prices. On the basis of butterfat the corresponding figures are 75.7 and 77.2 percent.

However, it must be noted that the "companion" cows, not fed Koa haole during the same years, produced milk and fat at a lower unit feed cost during the years when the experimental lot was being fed Koa haole. For milk, this was 86.8 percent that of the preliminary period on the basis of 1948 prices and 87.4 percent on the basis of 1953 prices. On the basis of butterfat the corresponding figures are 87.3 and 88.1 percent. The reasons for this reduction in unit feed cost of production of milk and fat by the same cows on the same feeds in different periods cannot readily be explained except to attribute it to better management or other favorable factors. Subtracting the reductions in feed costs per unit of production for the "companion" cows from those of the Koa haole fed cows during the same periods leaves a net saving in unit milk production cost of \$0.0011 at 1948 prices, and \$0.0007 at 1953 prices. Due to higher fat content, the reduction on unit fat production feed costs were greater—\$0.1220 and \$0.1032 based on 1948 and 1953 feed prices respectively.

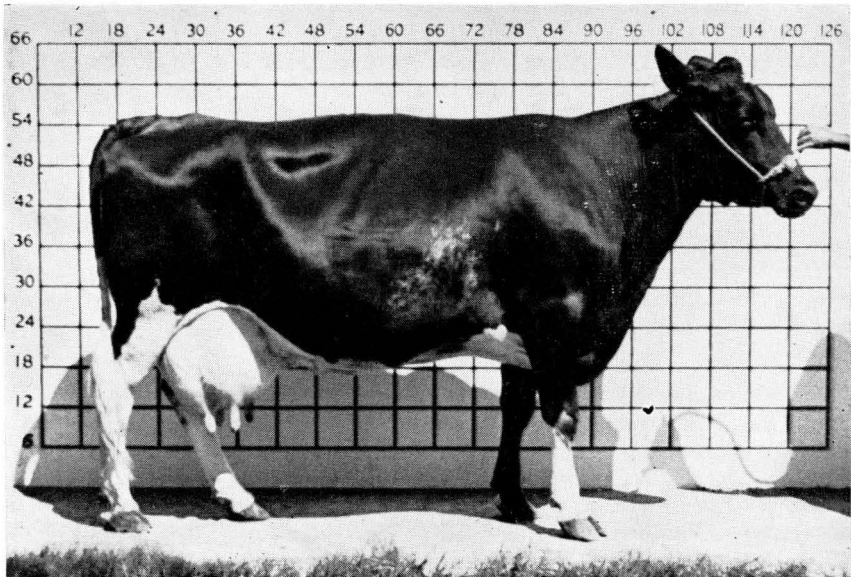
Reproductive Efficiency. In the Koa haole fed group, reproductive efficiency prior to Koa haole feeding was 98.16 percent; during the 5-year Koa haole feeding period, 87.67 percent. The "companion" cows, which were not fed Koa haole, averaged 102.76 and 89.74 percent during the corresponding periods. Hence, while there was a decline in reproductive efficiency in the group fed Koa haole, the decline was slightly greater with the "companion" group.

Value of Green Koa haole in Terms of Napier Grass. Evaluating Napier grass at \$6.00 per ton, and using cost of milk production as the basis, Koa haole was worth \$15.24 at 1948 concentrate feed prices and \$14.32 at 1953 prices. These values were arrived at by determining the feed cost per pound of milk produced during the preliminary period when Koa haole was not fed, applying this rate to the production during the Koa haole feeding period, deducting the concentrate feeding cost, and dividing the difference by the actual pounds of Koa haole fed to arrive at the value of each pound of Koa haole fed.

Comparison of Results with Previous 3-Year Test. In general, the results of this 5-year trial were similar to those secured in the 3-year test previously conducted at the Station. Highlights of these comparisons are shown below:



Cow 258 on 9-29-48 before Koa haole feeding.



Cow 258 after 5 years on Koa haole.

	<i>Earlier 3-year test</i>	<i>Present 5-year test</i>
Average daily green Koa haole consumption.....	65.9 lbs.	60.5 lbs.
Increased milk production when Koa haole was fed:		
On actual fiscal year basis.....	23.7%	28.6%
On mature equivalent fiscal year basis.....	19.8%	14.3%
On 305-day mature equivalent lactation basis.....	11.1%	15.3%
Increased milk production of "companion" cows during corresponding periods:		
On actual fiscal year basis.....	12.9%	14.2%
On mature equivalent fiscal year basis.....	8.7%	8.3%
On 305-day mature equivalent lactation basis.....	4.9%	11.9%
Net increase which may be credited to Koa haole feeding:		
On actual fiscal year basis.....	10.8%	14.4%
On mature equivalent fiscal year basis.....	11.1%	6.0%
On 305-day mature equivalent lactation basis.....	6.2%	3.4%
Percentage milk production feed costs when Koa haole was fed as compared with feed cost when Koa haole was not fed:		
5-year trial		
On 1948 price basis.....	-----	82.8%
On 1953 price basis.....	-----	84.8%
3-year trial		
On 1940 price basis.....	95.8%	-----
On 1948 price basis.....	79.9%	-----
Value of ton of green Koa haole based on evaluating green Napier grass at \$6.00 per ton:		
5-year trial		
On 1948 prices.....	-----	\$15.24
On 1953 prices.....	-----	\$14.32
3-year trial		
On 1940 prices.....	\$10.60	-----
On 1948 prices.....	\$15.68	-----

IS SUBSTITUTION OF KOA HAOLE FOR NAPIER GRASS DESIRABLE?

The results of this trial as well as previous trials were favorable to the use of Koa haole as a green roughage for milking cows.

Since Napier grass, which averages 75 tons per acre per year when amply fertilized with nitrogen, greatly outyields Koa haole, which averages about 25 tons, a much larger land area is needed to maintain a herd of a given size when feeding Koa haole. Hence land values, or rentals, or availability become important factors. The cost of protein supplements also becomes a factor; the higher the cost of a protein supplement, such as soybean oil meal, the greater will be the saving, since, except for very high producers, comparatively little high protein supplement is needed when feeding Koa haole.

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